Space Weather Technical Forecast

Issued on Monday, 30 January 2023 at 12:35 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1 from fast wind brought forward, probably peaking UTC days Tuesday into Wednesday.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with X-ray activity recorded at GOES16 comprising low-level C-class flares that became more frequent to end the period, peaking with a C2.0 at 30/0610UTC. The source was muddied by concurrent activity in a northeastern quadrant filament and a newly-arriving sunspot on the southeastern limb. The latter has yet to receive a number but appears to be bipolar at least.

There were otherwise four numbered sunspot regions on the solar disc, with these mostly small bipolar regions. The main activity was seen in AR3205 in the southwest which saw areal growth in its penumbra and some proliferation and spreading, while AR3206 in the southeast saw intermediate spot proliferation.

Coronagraph imagery available for the period suggests a large southwest-directed series of CMEs that may possibly relate to a frontside prominence lift off at low latitude, although some of the obtained modelling solutions suggest this may be angled towards the far side. In any case, no Earth-based effects are expected. Additionally, coronagraph imagery is showing an apparently mainly southeastward-directed CME, although again this is off-ecliptic and possibly far-sided from provisional CME fitting. At present then, there remain no Earth-directed CMEs in evidence.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, is suggestive of Earth's exit from the influence of a positive polarity coronal hole, most likely CH71/+ into a nominal solar wind regime, with the phi angle positive (away from the Sun) until 29/2340UTC, with a switch to negative territory suggesting that the transition has been completed.

The solar wind speed showed a gradual decline through the period, falling through Slightly Elevated levels from 500 to 400km/s in the 24 hours. The solar wind density over the same period showed a shallower decline, and remained within normal levels in single figures ppcc. The IMF showed smooth and small-scale variation at or below 5nT throughout, with a variable north-south component between +/-4nT.

The net effect of the above solar wind measures was provisionally Quiet geomagnetic activity throughout, peaking with Kp '2o'.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.

High energy electron flux (greater than 2 MeV) has been at Normal Background to Moderate levels, peaking at 606pfu at 29/1705UTC. The associated 24-hour integrated electron fluence has drifted upwards but remains well below the Active threshold, with 1.93e7 integrated pfu

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observed at 30/0001UTC.

Four-Day Space Weather Forecast Summary

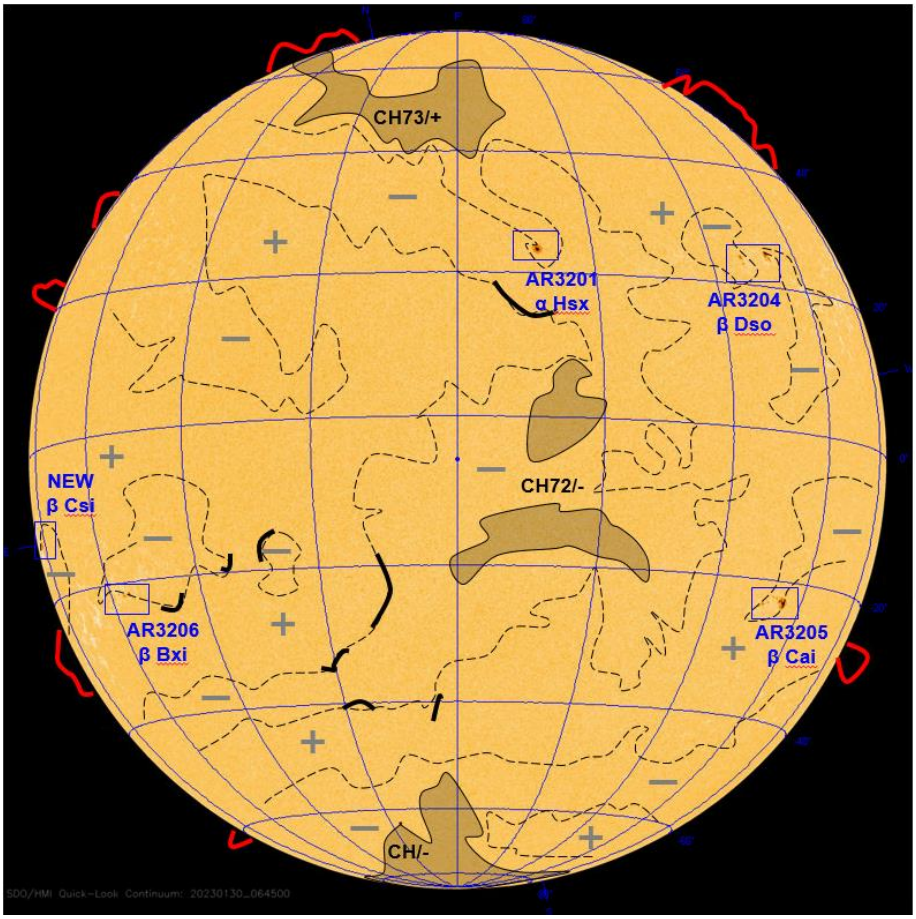
Solar Activity: Solar activity is Expected to be predominantly Low, with a daily Slight Chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the forecast. A fast wind is potentially now showing at STEREO A, which would affect Earth from day two, Tuesday 31 January and give a Chance of G1, perhaps continuing into day three before beginning to wane.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is expected to remain at Background levels.

Electron flux may increase slightly in the next 24 hours or so but is unlikely to result in Active fluence. A second, larger peak may develop later this working week in the wake of the fast wind onset from CH72/-. The degree to which this occurs is low confidence, but fluence will probably reach a peak for the week as a whole as a result.

Figure 1. Solar Analysis Valid 30/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs currently feature in the four-day forecast, and Earth is now considered to have left the prior influence of CH71/+, with a slow regime observed in recent hours.

The geomagnetic forecast therefore comprises exclusively coronal hole activity, namely from northern hemisphere CH73/-, or perhaps more likely equatorial CH72/-, the latter having a leading edge nearing 30W as of the time of the latest MOSWOC synoptic map (30/0645UTC).

The above coronal holes do have analogues from last rotation, however the resulting geomagnetic activity was muted - Quiet to Unsettled. Changes in coronal hole geometry between the passes are relatively slight, and the dominant effect is more likely to be the relative proximity to the vernal equinox when considering effects for the current disc and the analogous features' last outing.

Solar wind speeds of around 500km/s were seen 27 days ago, however the latest STEREO A MAG and PLASTIC data has a negative polarity fast wind now showing, with few, erratic solar wind speed data points. Those available at the time of writing do suggest something faster may have affected the satellite, perhaps nearer 700km/s, although this is treated with suspicion given the low densities involved and possible influence of a CME that was overdue as a glance at STEREO A at the time of the solar wind measure increases.

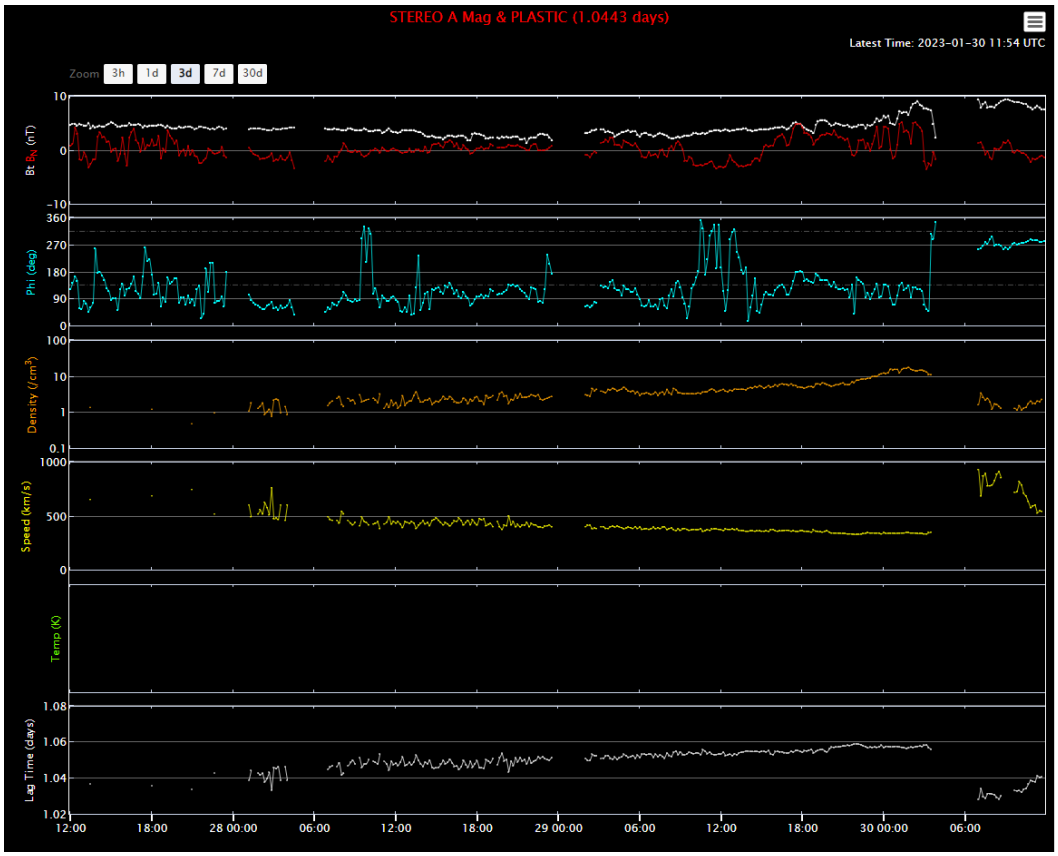
STEREO A Mag & PLASTIC (1.0443 days)
Latest Time: 2023-01-30 11:54 UTC
Zoom 3h 1d 3d 7d 30d
Bt Bx (nT)
Phi (deg)
Density (/cm³)
Speed (km/s)
Temp (K)
Lag Time (days)
12:00 18:00 28 00:00 06:00 12:00 18:00 29 00:00 06:00 12:00 18:00 30 00:00 06:00

Figure 2: 3-day STEREO A MAG and PLASTIC measurements, suggesting a possible Elevated to Strong negative polarity fast wind may currently be affecting the satellite, which puts any Earth arrival inside around 24 hours' time. The onset time for this fast wind has been brought forward and the relative risk of G1 has been revised upwards as a result.

All of the above considered, confidence is perhaps lower than is typical for a recurrent feature

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given STEREO A information, but a fast wind arrival may now feature at L1 and Earth as early as the middle of day two, Tuesday 31 January, with a resultant Chance of G1 perhaps persisting midweek before waning with the solar wind speed later in the working week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	25	25	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 3: AIA211 imagery from last pass and the current rotation, showing a broadly similar appearance and leading edge for coronal hole 72/- near the solar equator in the western hemisphere.

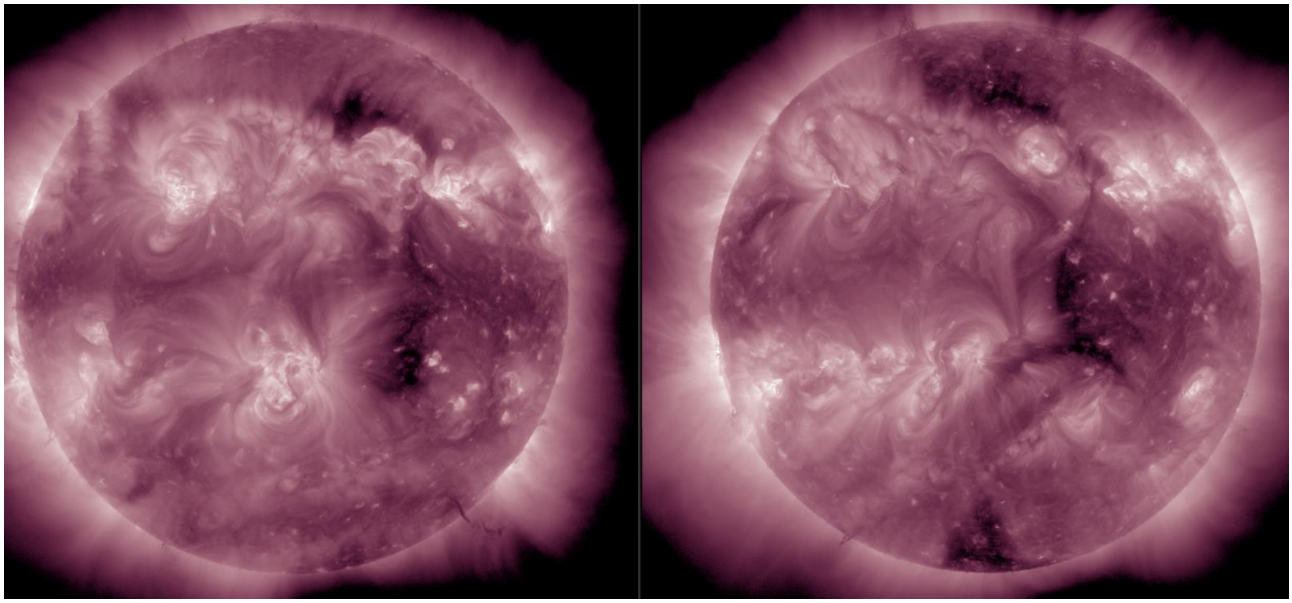

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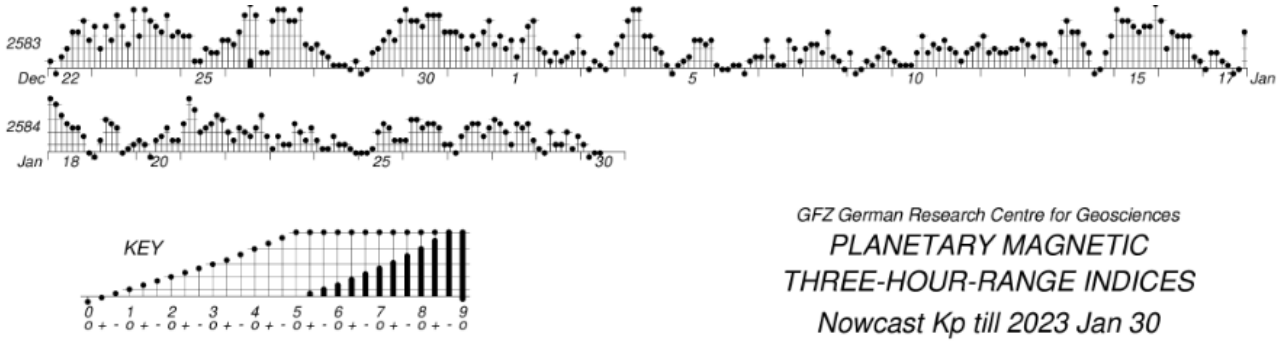
Figure 4: Bartels music plot showing the expected relative lack of geomagnetic activity resulting from the above coronal holes, although the latest STEREO A data may challenge this assumption.


2583
Dec 22 25 30 1 5 10 15 17 Jan
2584
Jan 18 20 25 30
KEY
0 1 2 3 4 5 6 7 8 9
0 + - 0 + - 0 + - 0 + - 0 + - 0 + - 0 + - 0 + - 0
GFZ German Research Centre for Geosciences
PLANETARY MAGNETIC
THREE-HOUR-RANGE INDICES
Nowcast Kp till 2023 Jan 30

Radio Blackouts - X-Ray Flares:

The Earth-facing disc has significantly depopulated in the past week, with those four (now possibly five) sunspot groups that do remain all smaller and simpler than their recent forebears.

The eastern limb is likely to contribute more in the period than the western solar horizon removes from consideration, with only two small sunspot regions due to leave the front side around the middle of the coming working week. The Carrington locations for Ex-3182, 3187, 3189 and 3193 are all due to arrive in succession in the period, while far side soundings persist in showing numerous large areas of at least plage.

The probable direction of X-ray activity is upward over the four days, however the degree to which this occurs remains to be seen pending these new arrivals, with a Slight Chance of M-class maintained in the meantime throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

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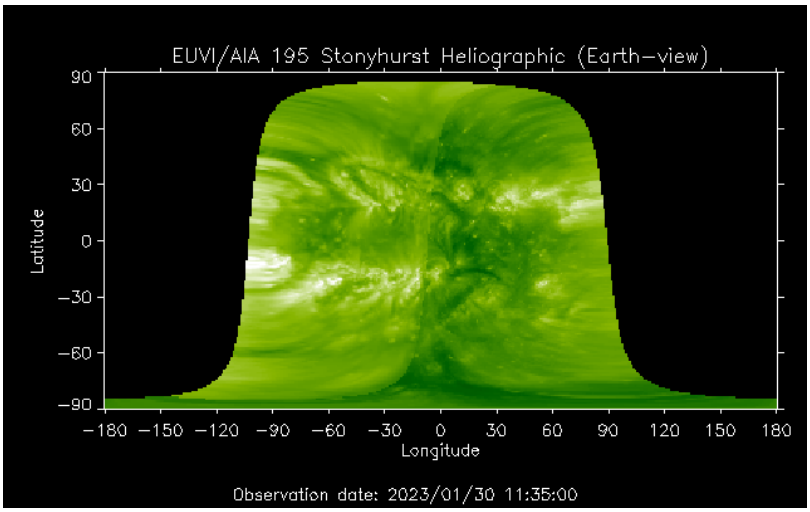
Figure 5: EUVI195 imagery showing the impending eastern limb from STEREO A's perspective between 90 and 105 East. Note the bright flux in the south which may correspond to returning Ex-3182.



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently expected to persist at Background levels, with relatively fewer and simpler potentially causative sunspots on the Earth-facing disc than of late.

Radiation Storms Probability (Exceedance)	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC) (%)**	**Day 2 (00-24 UTC) (%)**	**Day 3 (00-24 UTC) (%)**	**Day 4 (00-24 UTC) (%)**
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is currently varying diurnally between Normal Background and Moderate levels. A degree of upward reaction is considered possible before midweek in response to the fast wind from CH71/+, however this is felt unlikely to be of sufficient magnitude to trouble the Active 24-hour integrated fluence threshold. Flux is currently around a order of magnitude lower than on last pass, and the latest run of MOSWOC REFM persists in a relatively flat 72-hour forecast trend, which is accepted given the fact the geomagnetic forecast exclusively comprises recurrent coronal holes and no transients.

A second upward response may follow any fast wind from CH72/- (or CH73/-), perhaps featuring at the very end of the coming four days, although only really becoming established to end the current working week. Ideas as to the extent to which this occurs are uncertain because of the recent earlier and larger magnitude than expected fast wind enhancement at STEREO A - confidence should improve in around 24 hours' time when the cause will be clearer (and possibly showing at L1).

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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